EPICA deep ice core, an archive for millennial climate change

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foto: hans oerter, 31.01.2006

Introduction: EPICA

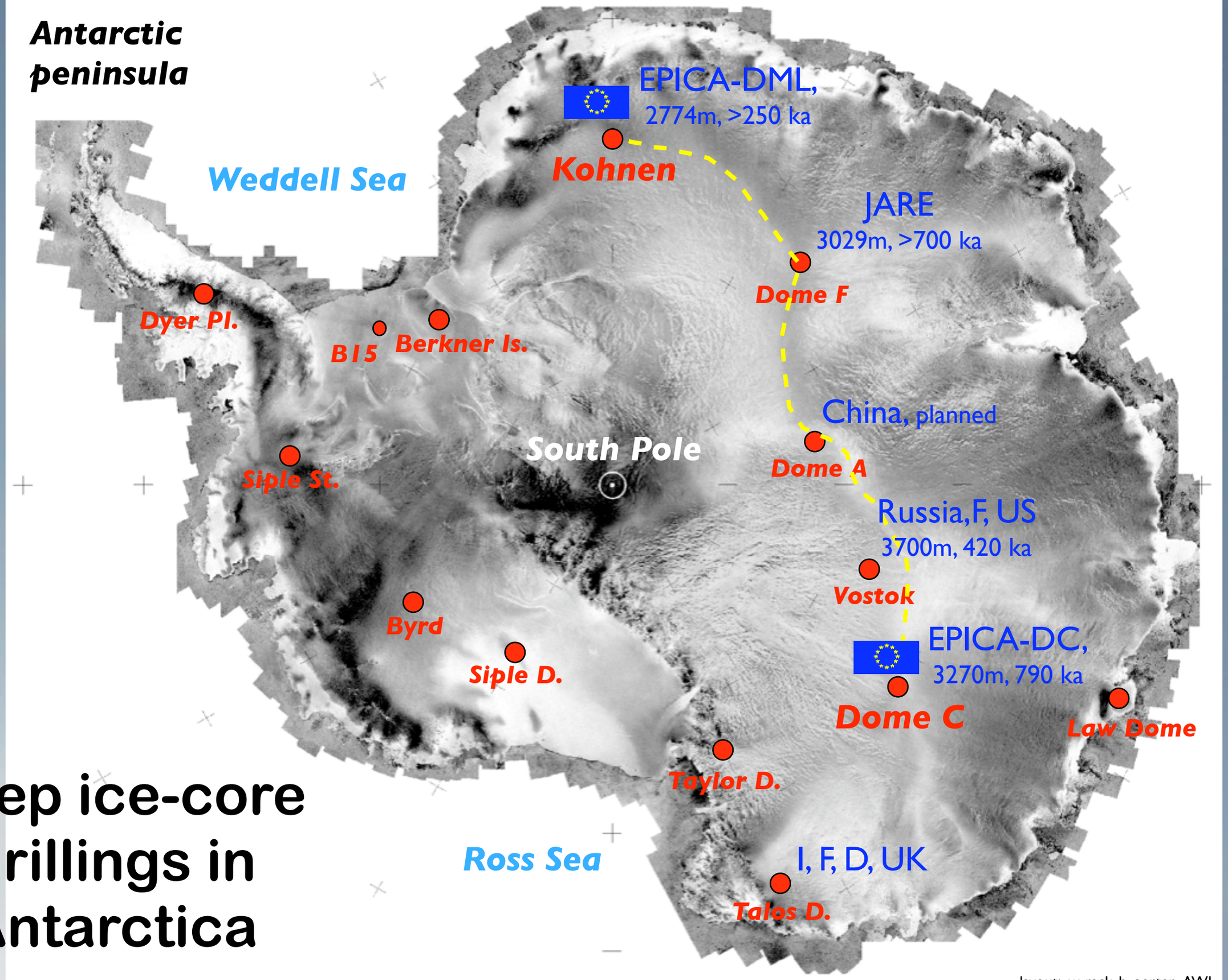
The past Glacial

The Holocene

Conclusions

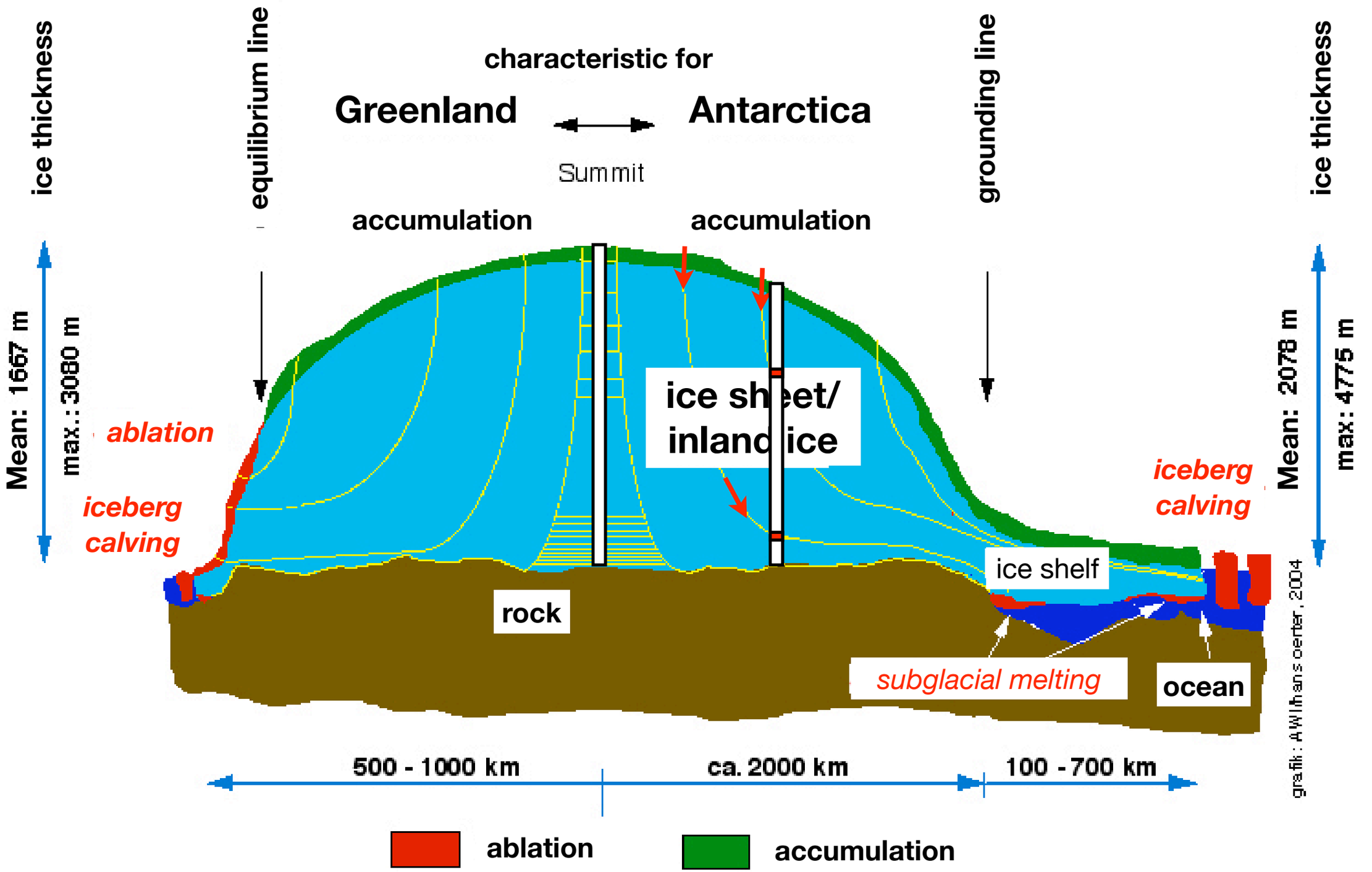
foto: hans oerter, 2008

Deep ice-core drillings in Antarctica



layout: w. rack, h. oerter, AWI

Schematic cross section through an ice sheet



The climatic record of the EDML ice core

Kohnen Station

75°00‘09“S, 00°04‘06“E,
2892 m (WGS84)

Drilling operation:
2001-2006

Annual mean air
temperature: -45 °C

Accumulation rate:
65 kg $m^{-2}a^{-1}$

Ice flow velocity:
0.756 m/a

Ice thickness:
2782 ±10m

Length of ice core:
2774.1 m

foto: hans oerter, 2006

The climatic record

$\delta^{18}O$

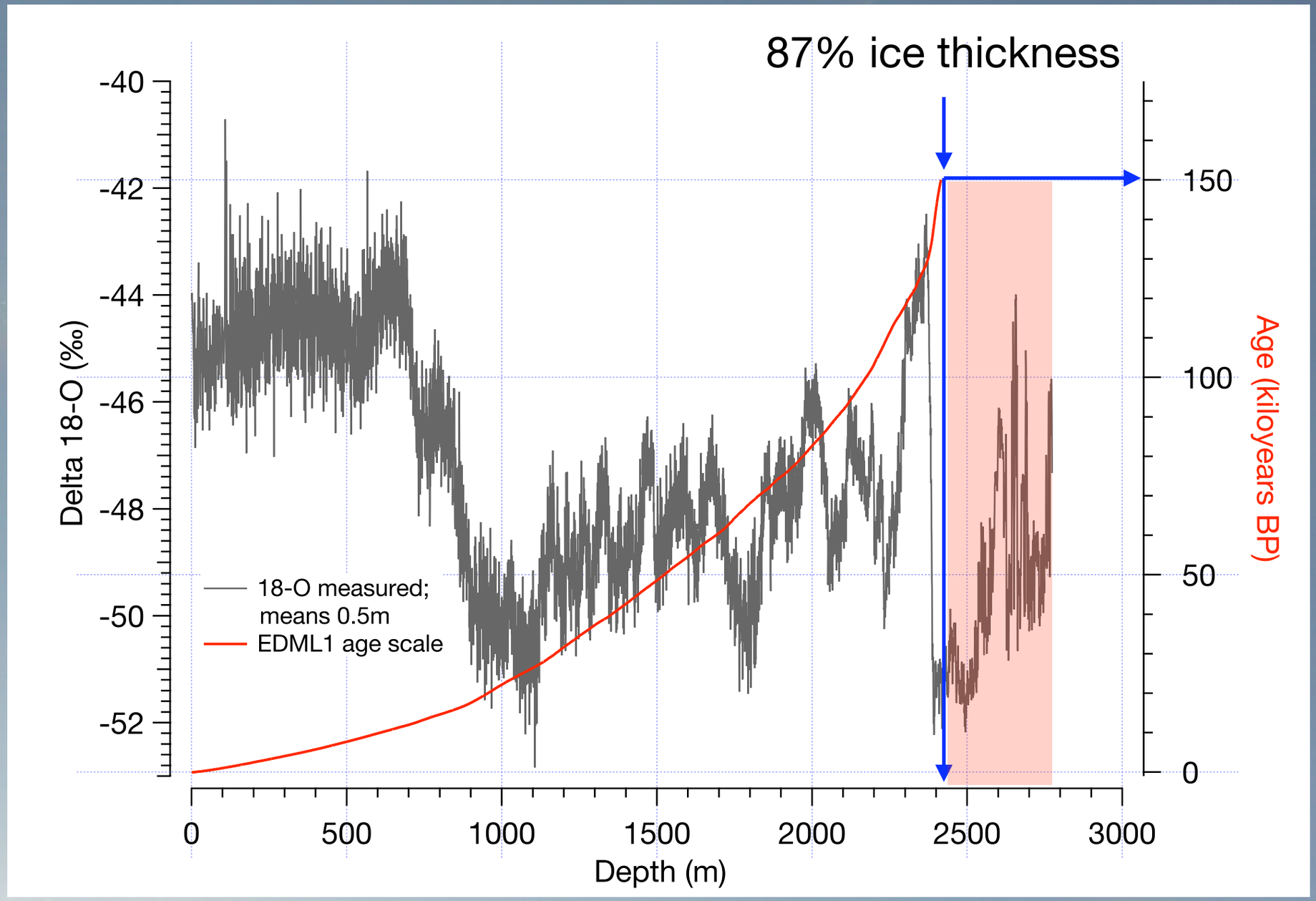
foto: hans oerter, 2008

The climatic record of the EDML ice core

sample resolution:
0.5 m
corresponding to
at 125 m: 6 a
at 2400 m: 280 a

EDML ice core
dated down to
2416 m with
EDML1 age scale:
150.1 ka

For the Holocene
and other
selected intervals
also 5cm samples
available

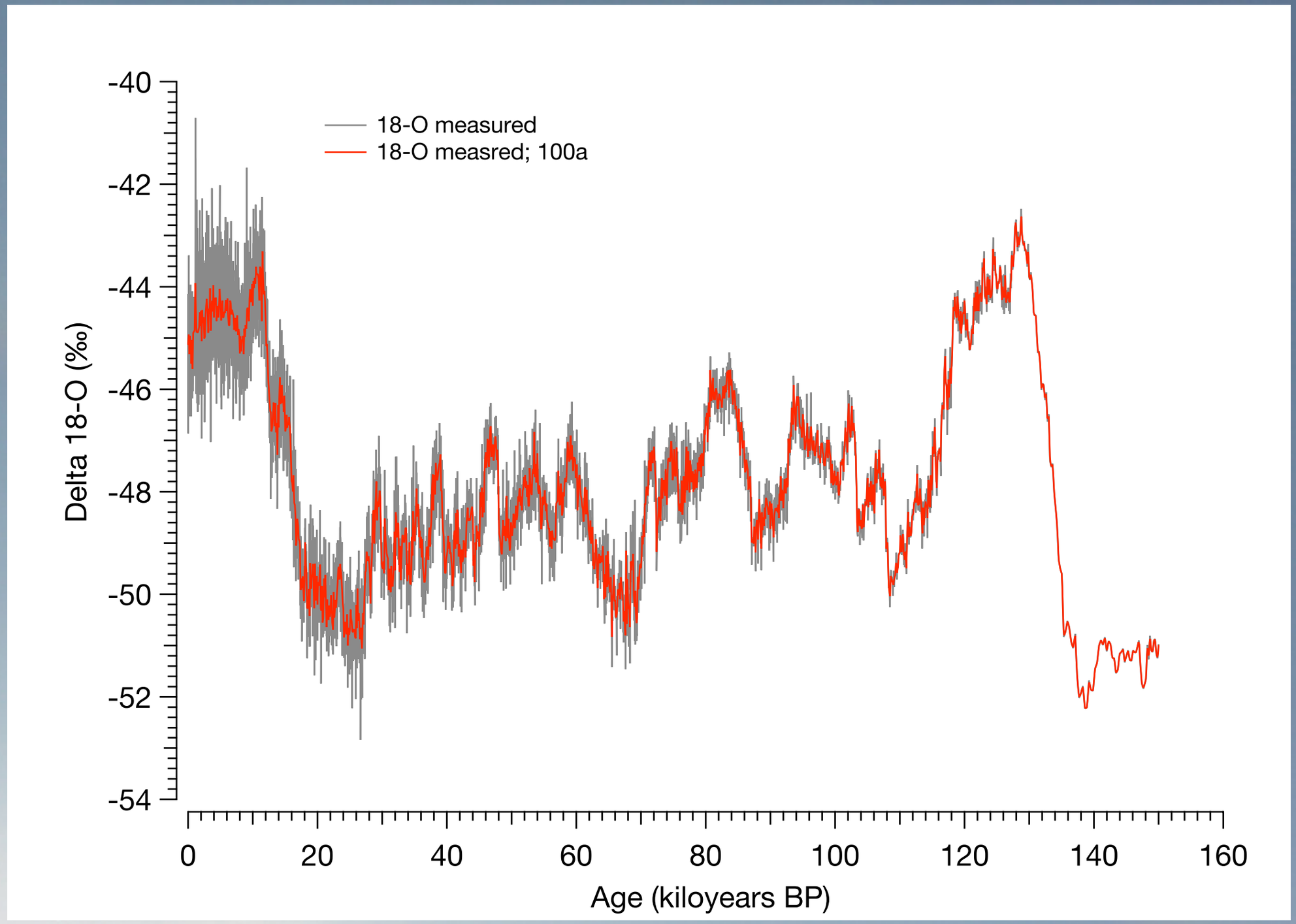


data: EPICA Community Members (2006): One-to-one coupling of glacial climate variability in Greenland and Antarctica. *Nature* **444**, 195-198. data: **doi:10.1594/PANGAEA. 552270**

Measurements of the stable isotope ^{18}O given as δ-values in ‰ V-SMOW

The climatic record of the EDML ice core

Raw data



data: EPICA Community Members (2006): One-to-one coupling of glacial climate variability in Greenland and Antarctica. *Nature* **444**, 195-198. data: **doi:10.1594/PANGAEA. 552270**

Data of $\delta^{18}O$ plotted against time; 0.5m samples (grey) and re-sampled on 100a intervals (red)

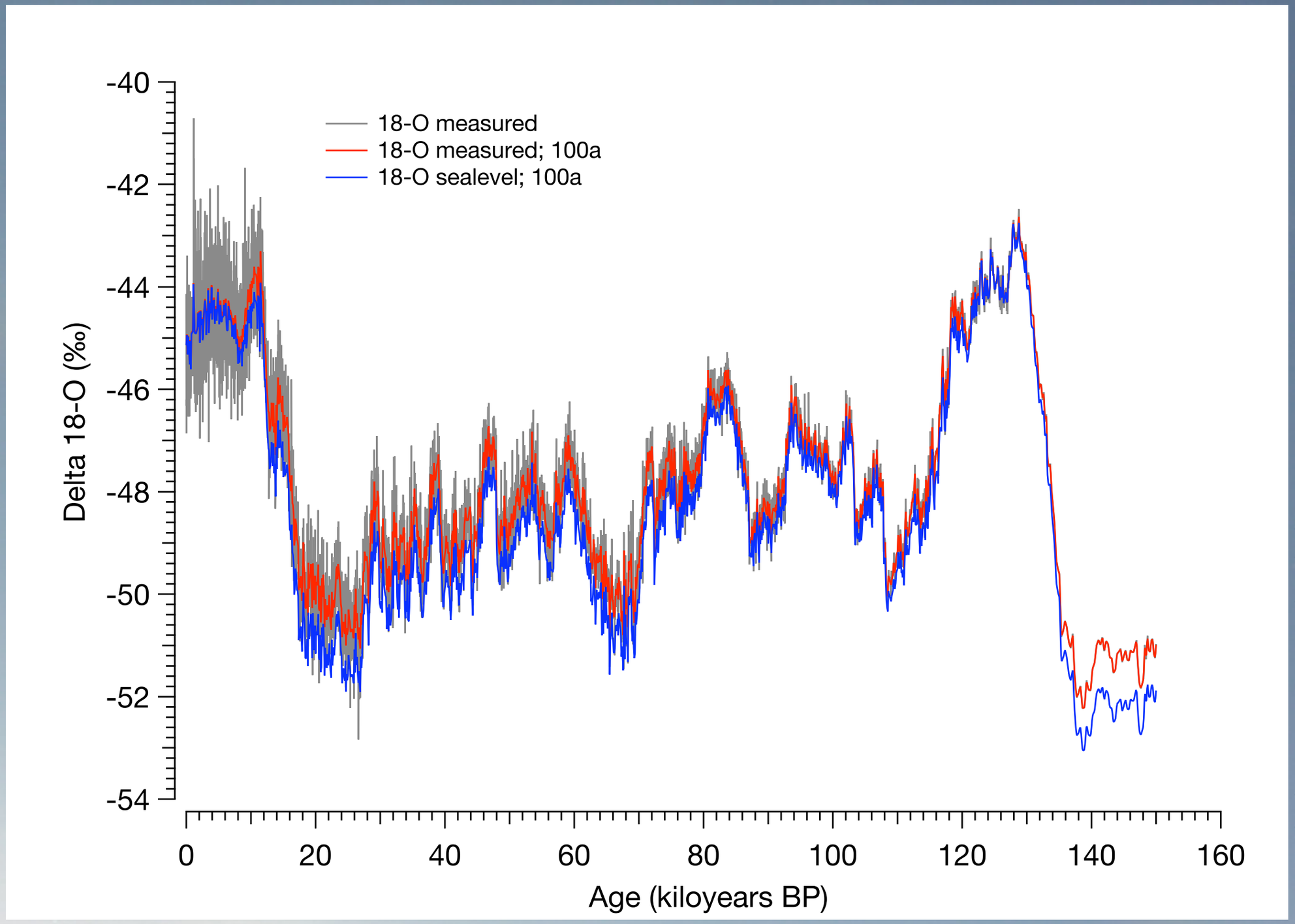
(AnaySeries2.0 software, Paillard et al., EOS Trans. AGU, 1996)

The climatic record of the EDML ice core

Raw data

+

sea level correction



data: EPICA Community Members (2006): One-to-one coupling of glacial climate variability in Greenland and Antarctica. *Nature* **444**, 195-198. data: **doi:10.1594/PANGAEA. 552270**

Data of $\delta^{18}O$ corrected for sea level change in the past and re-samped on 100a intervals (blue)

(AnaySeries2.0 software, Paillard et al., EOS Trans. AGU, 1996)

The climatic record of the EDML ice core

Raw data

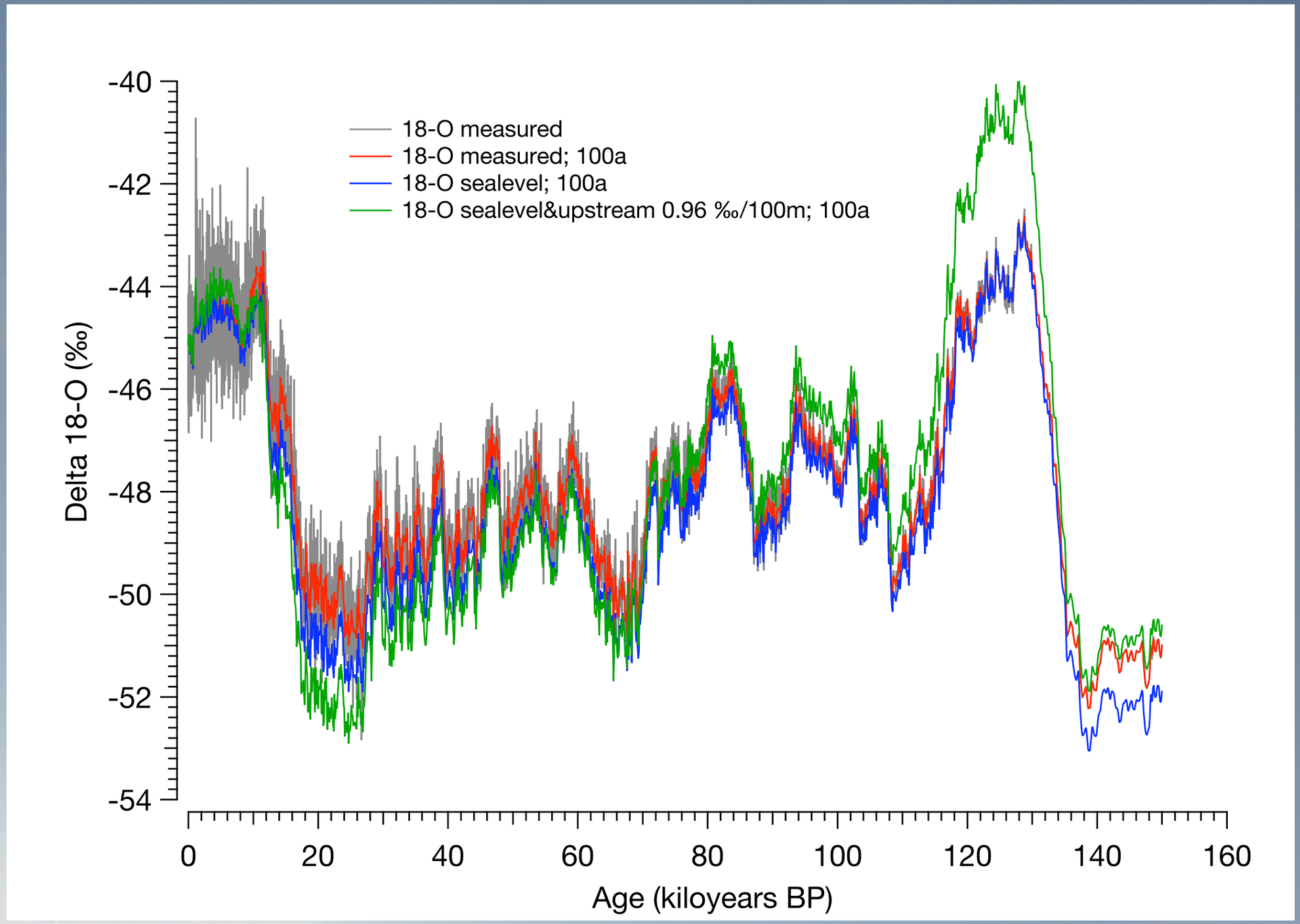
+

sea level correction

+

upstream correction

0.96‰/100m



data: EPICA Community Members (2006): One-to-one coupling of glacial climate variability in Greenland and Antarctica. *Nature* **444**, 195-198. data: **doi:10.1594/PANGAEA. 552270**

Data of $\delta^{18}O$ corrected for elevation differences between Kohnen and site of deposition (green)

(AnaySeries2.0 software, Paillard et al., EOS Trans. AGU, 1996)

The climatic record of the EDML ice core

Raw data

+

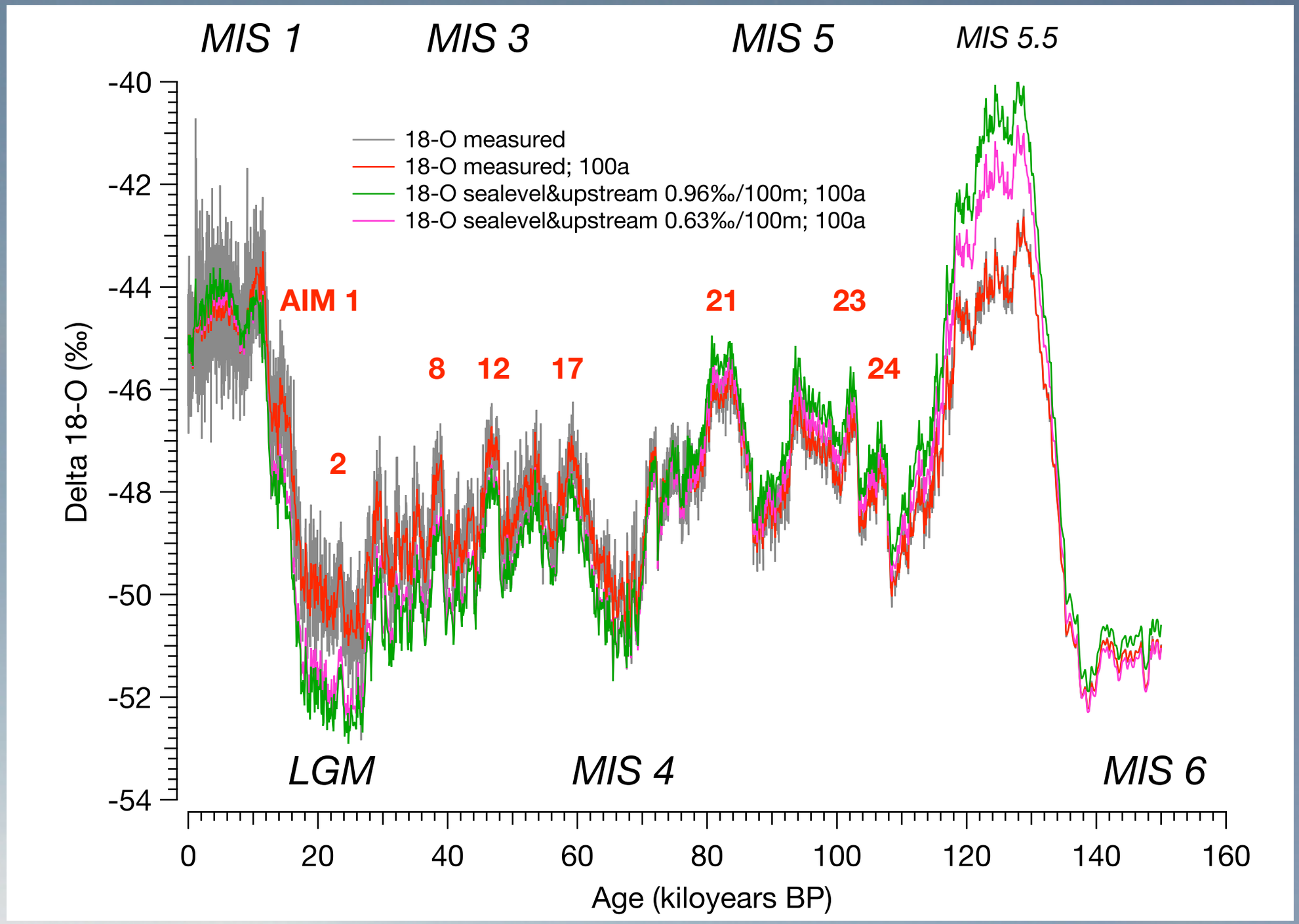
sea level correction

+

upstream correction

0.96‰/100m

0.63‰/100m



data: EPICA Community Members (2006): One-to-one coupling of glacial climate variability in Greenland and Antarctica. *Nature* **444**, 195-198. data: **doi:10.1594/PANGAEA. 552270**

Data of $\delta^{18}O$ corrected for elevation differences between Kohnen and site of deposition (green/pink)

(AnaySeries2.0 software, Paillard et al., EOS Trans. AGU, 1996)

The climatic record of the EDML ice core

Raw data

+

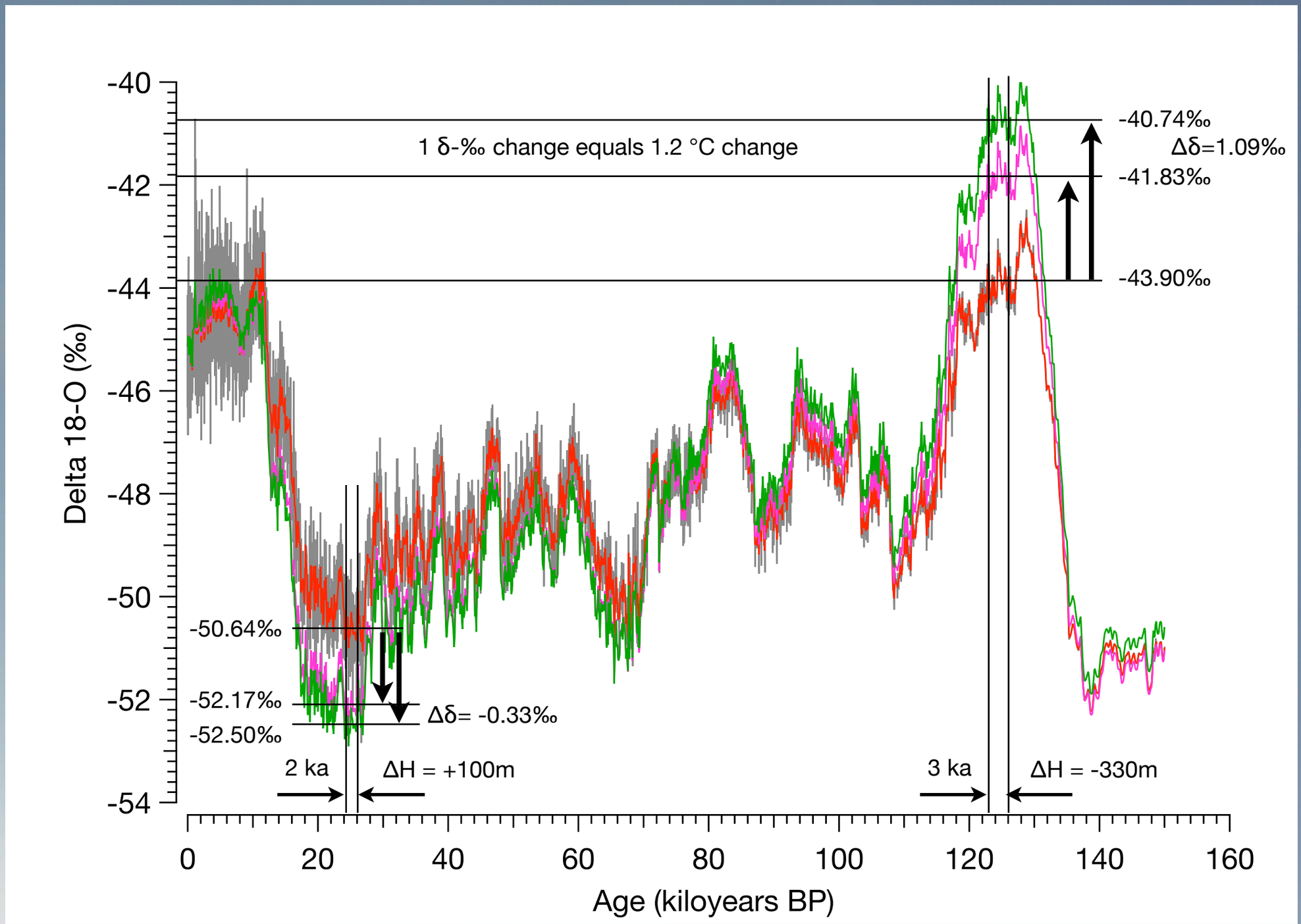
sea level correction

+

upstream correction

0.96‰/100m

0.63‰/100m



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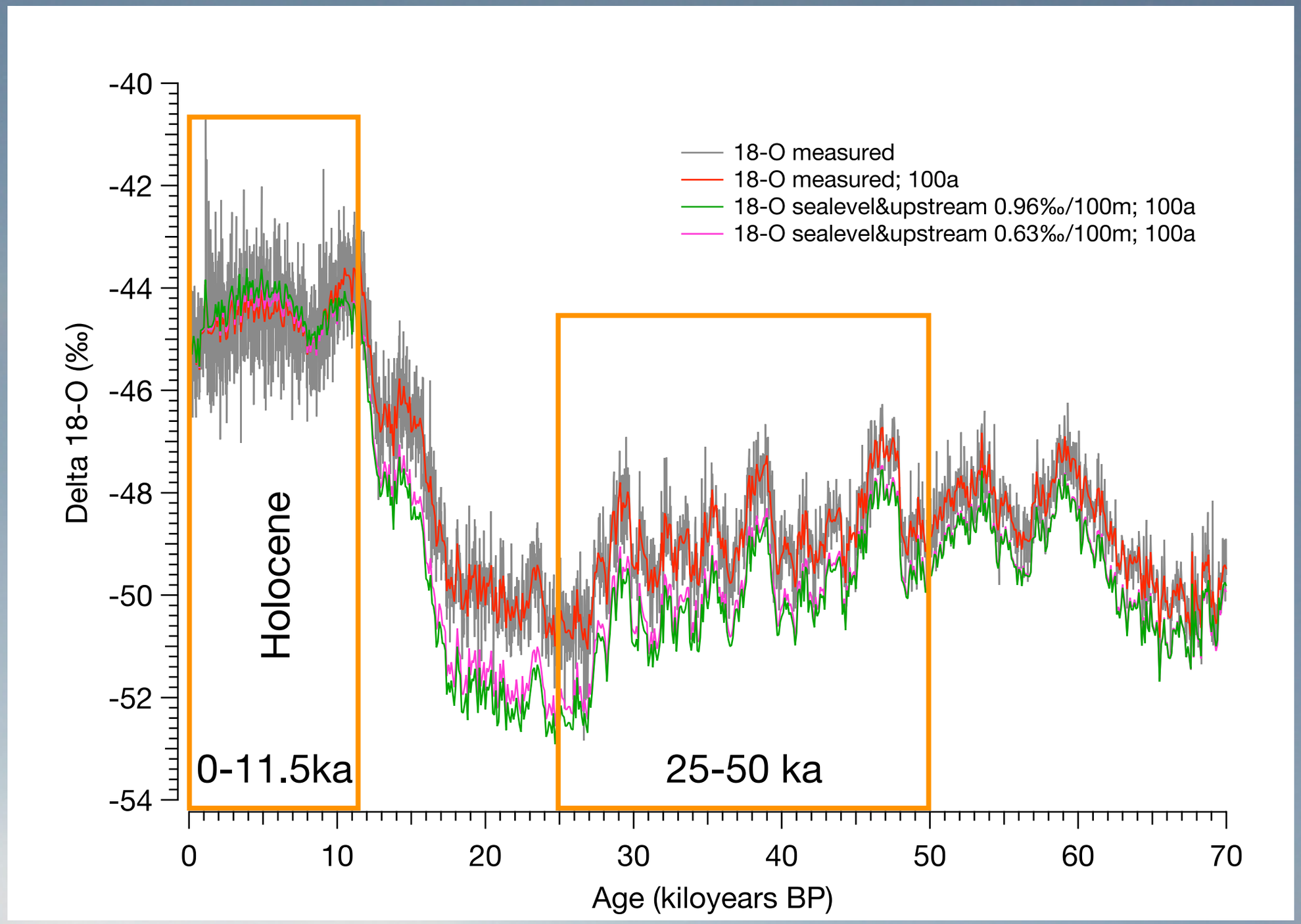
Data of $\delta^{18}O$ corrected for elevation differences between Kohnen and site of deposition (green/pink)

(AnaySeries2.0 software, Paillard et al., EOS Trans. AGU, 1996)

The climatic record of the EDML ice core



2 time slices for millenial variability

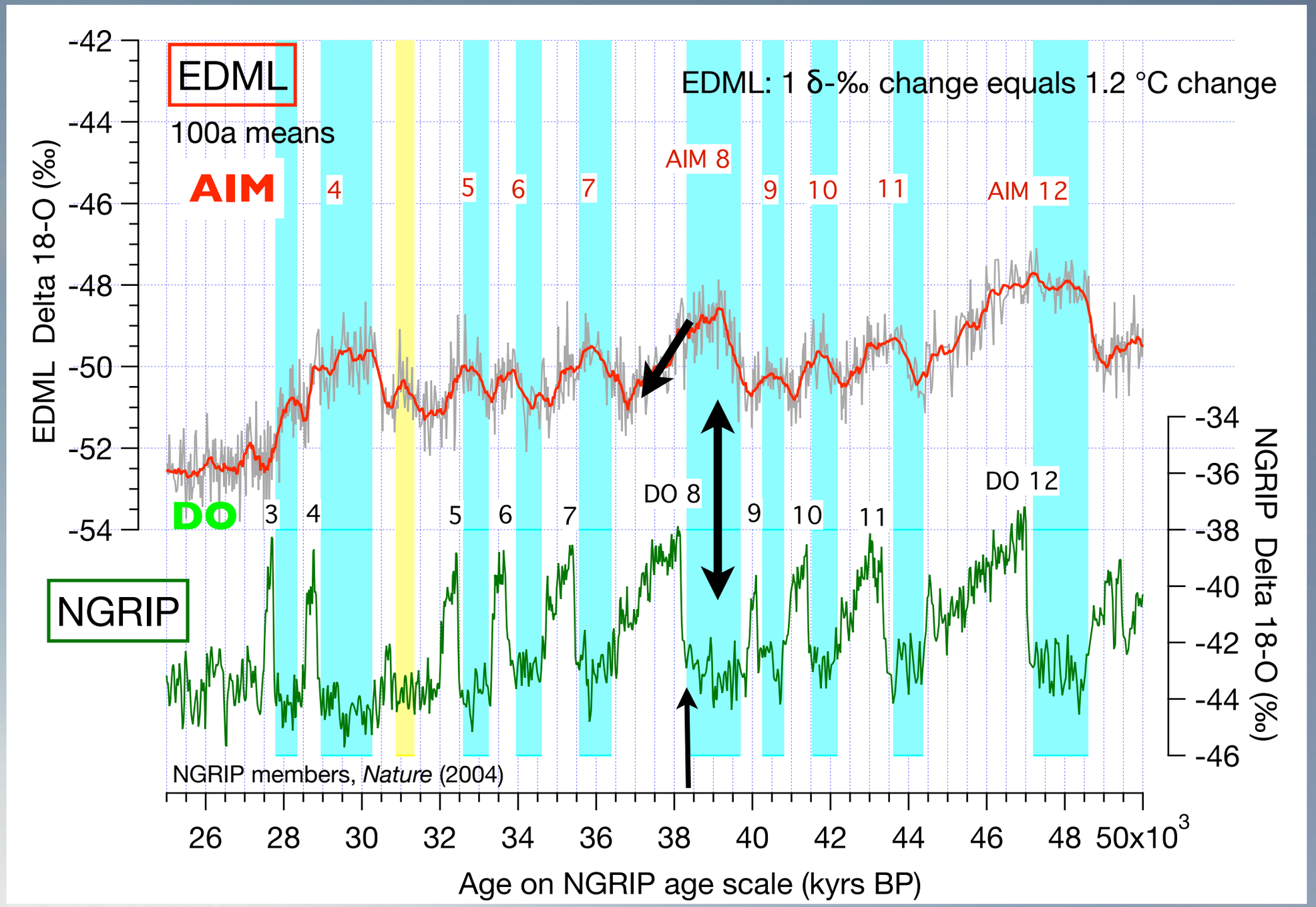
The past Glacial
(25-50 kyears B.P.)

foto: hans oerter, 2008

Comparison Antarctica (EDML) - Greenland (NGRIP)

Each Antarctic Isotope Maximum (AIM) in the EDML-ice core corresponds to a Dansgaard/ Oeschger (DO) event in Greenland (NGRIP)

Warming in Antarctica starts in a cold phase (Stadial) of the North, Cooling in a warm phase (Interstadial)



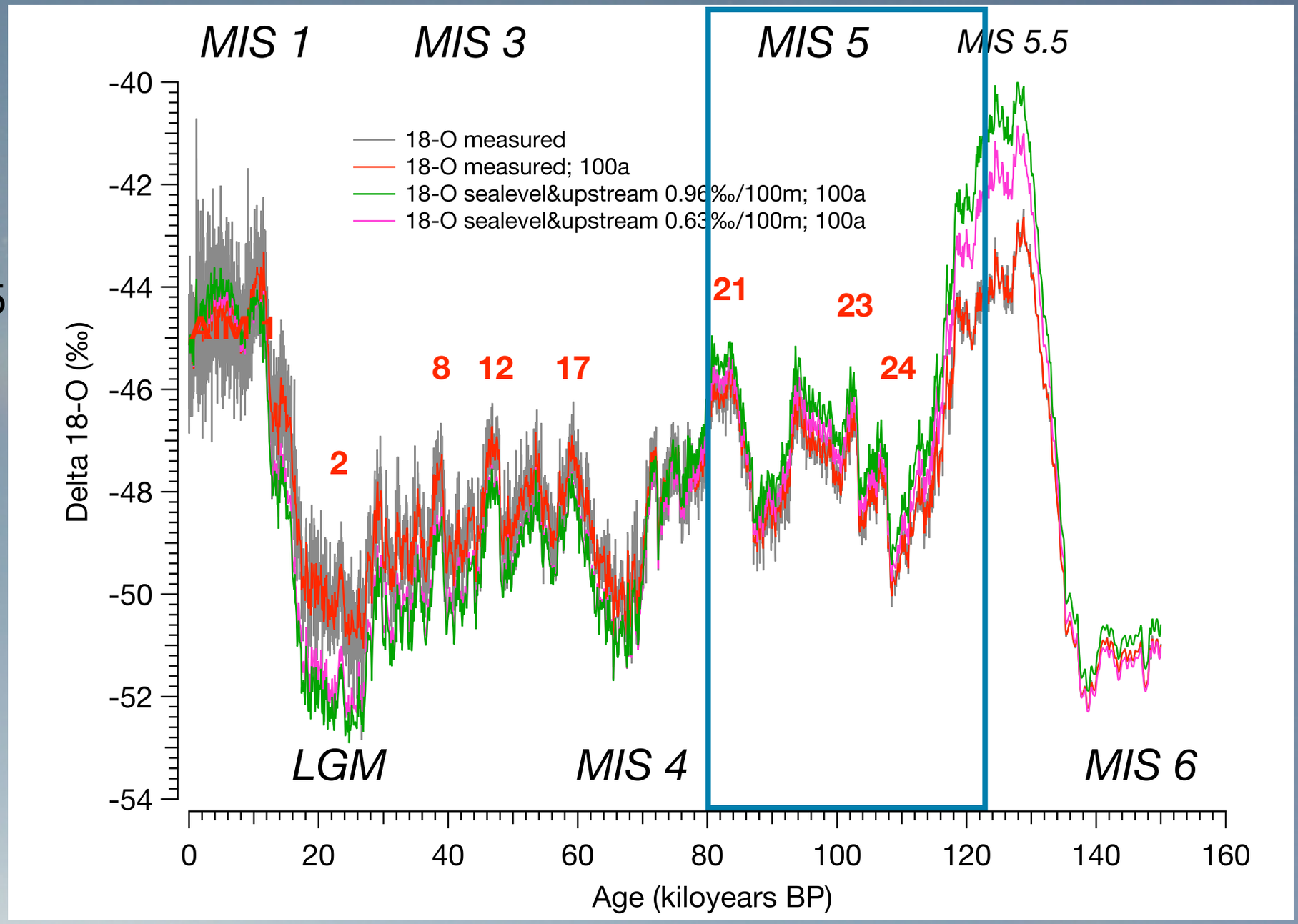
Source: EPICA Community Members: *Nature*, **444**, 195-198, (2006). data: **doi:10.1594/PANGAEA.552235**

The climatic record of the EDML ice core

The bi-polar seesaw

is also evident for MIS 5 as shown by E. Capron et al. (subm.) by synchronizing EDML and NGRIP with CH_4 & $\delta^{18}O_{atm}$ for the period 80-123 ka BP.

The bi-polar seesaw is also very likely for earlier Glacials (Jouzel et al., *Science* 2007)



data: EPICA Community Members (2006): One-to-one coupling of glacial climate variability in Greenland and Antarctica. *Nature* **444**, 195-198. data: **doi:10.1594/PANGAEA. 552270**

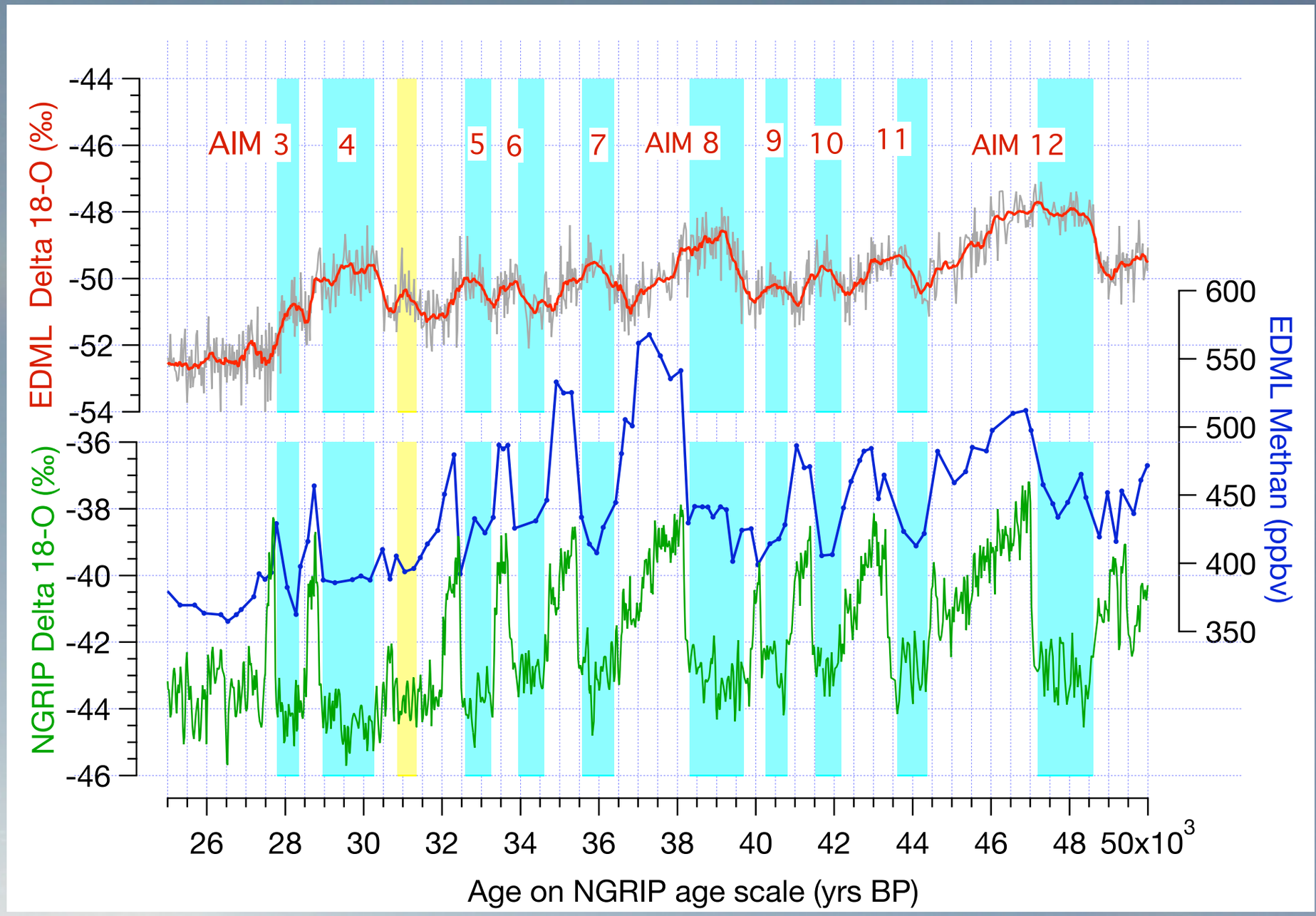
E. Capron et al.: Synchronising EDML and NorthGRIP ice cores using $\delta^{18}O$ of atmospheric oxygen ($\delta^{18}O_{atm}$) and CH_4 measurements over MIS 5 (80-123 ka). submitted to *Quaternary Science Reviews*

CH_4 concentrations at EDML

CH_4 variations synchronous on global scale:
tool to synchronize ice cores

CH_4 synchronous with DO events in Greeland

CH_4 signal of the Northern Hemisphere



Source: EPICA Community Members: *Nature*, **444**, 195-198, (2006).
data: **doi:10.1594/PANGAEA.552235** & **doi:10.1594/PANGAEA.552232**

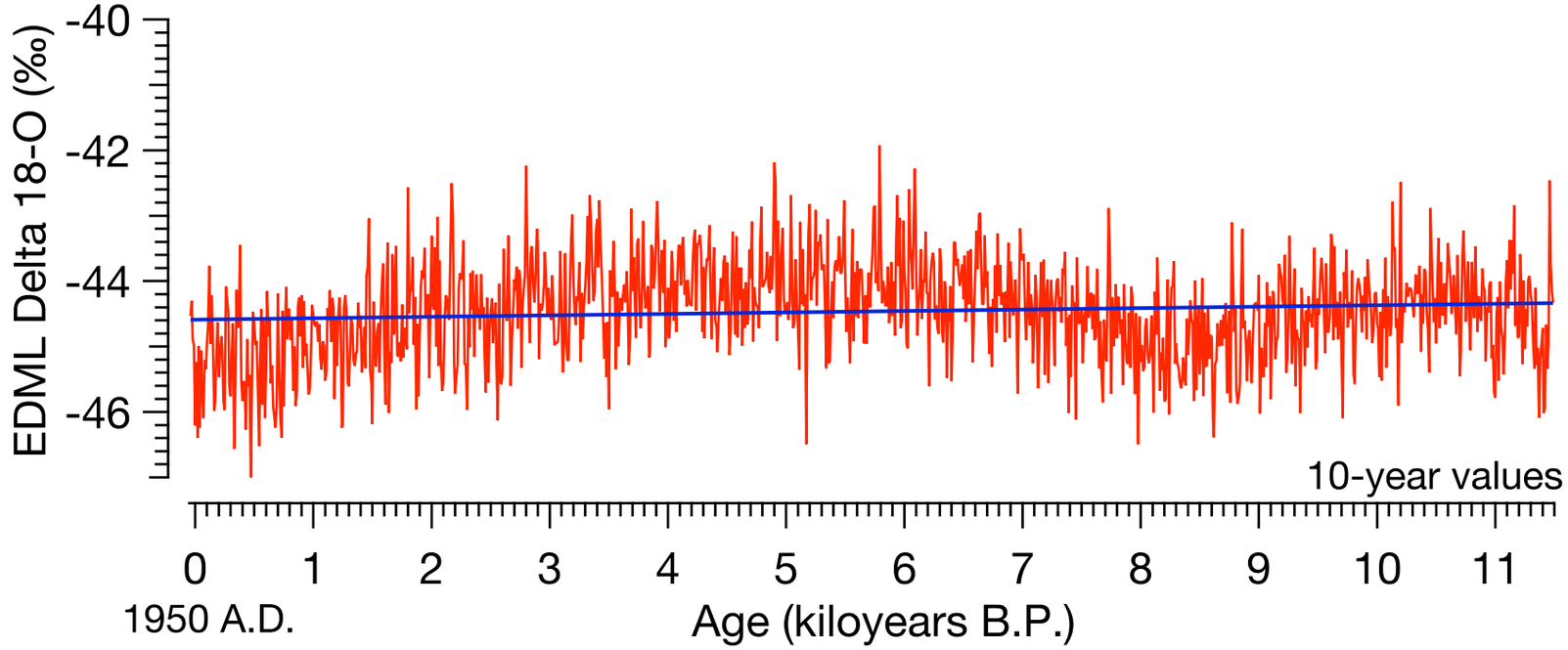
The Holocene

The $\delta^{18}O$ record

foto: hans oerter, 2008

The Holocene

EPICA EDML core

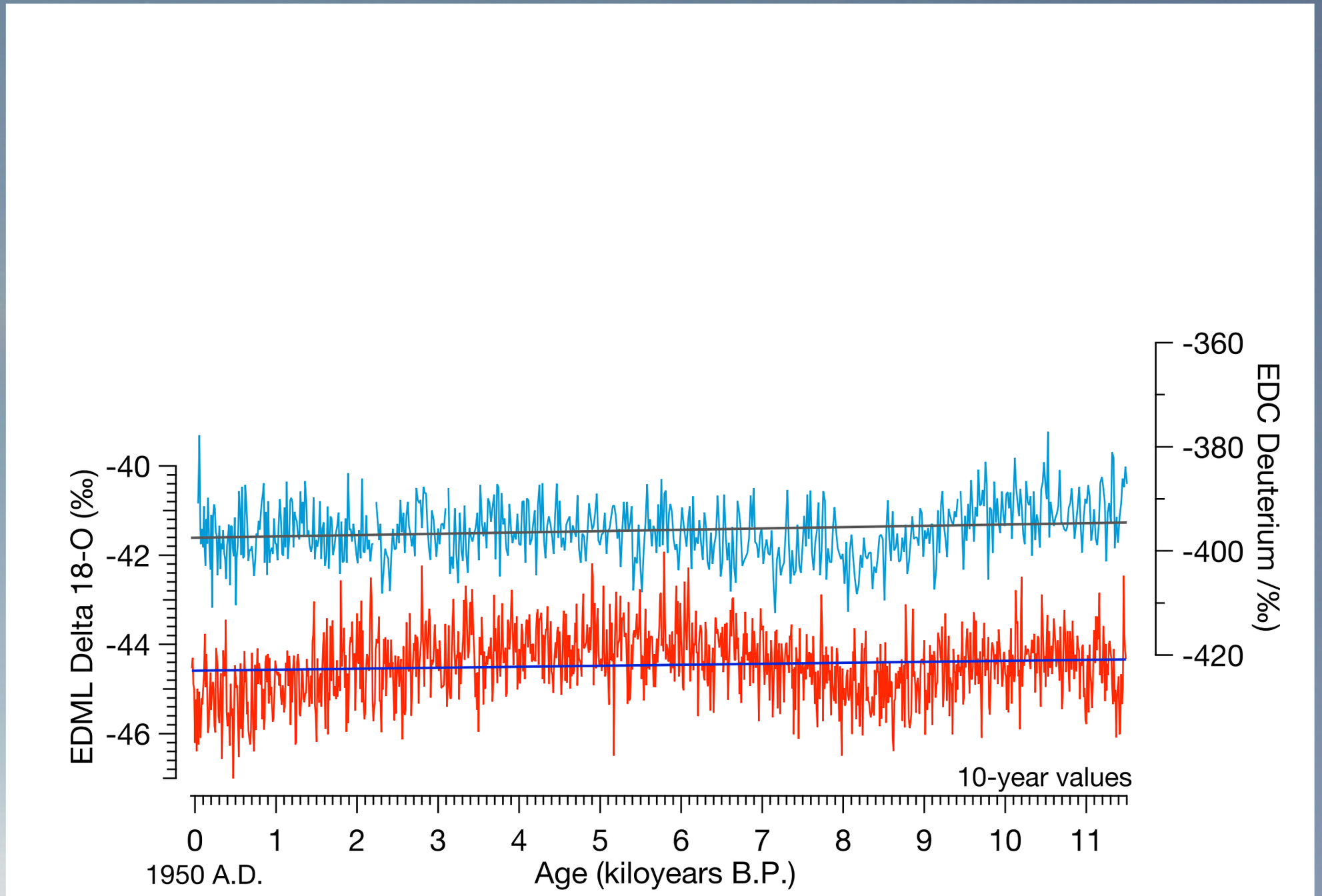


EPICA Community Members (2006): One-to-one coupling of glacial climate variability in Greenland and Antarctica. *Nature* **444**, 195-198 (data: **doi:10.1594/PANGAEA.552270)**

The Holocene

EPICA EDC core

EPICA EDML core



EPICA Community Members (2006): One-to-one coupling of glacial climate variability in Greenland and Antarctica. *Nature* **444**, 195-198 (data: **doi:10.1594/PANGAEA.552270)**

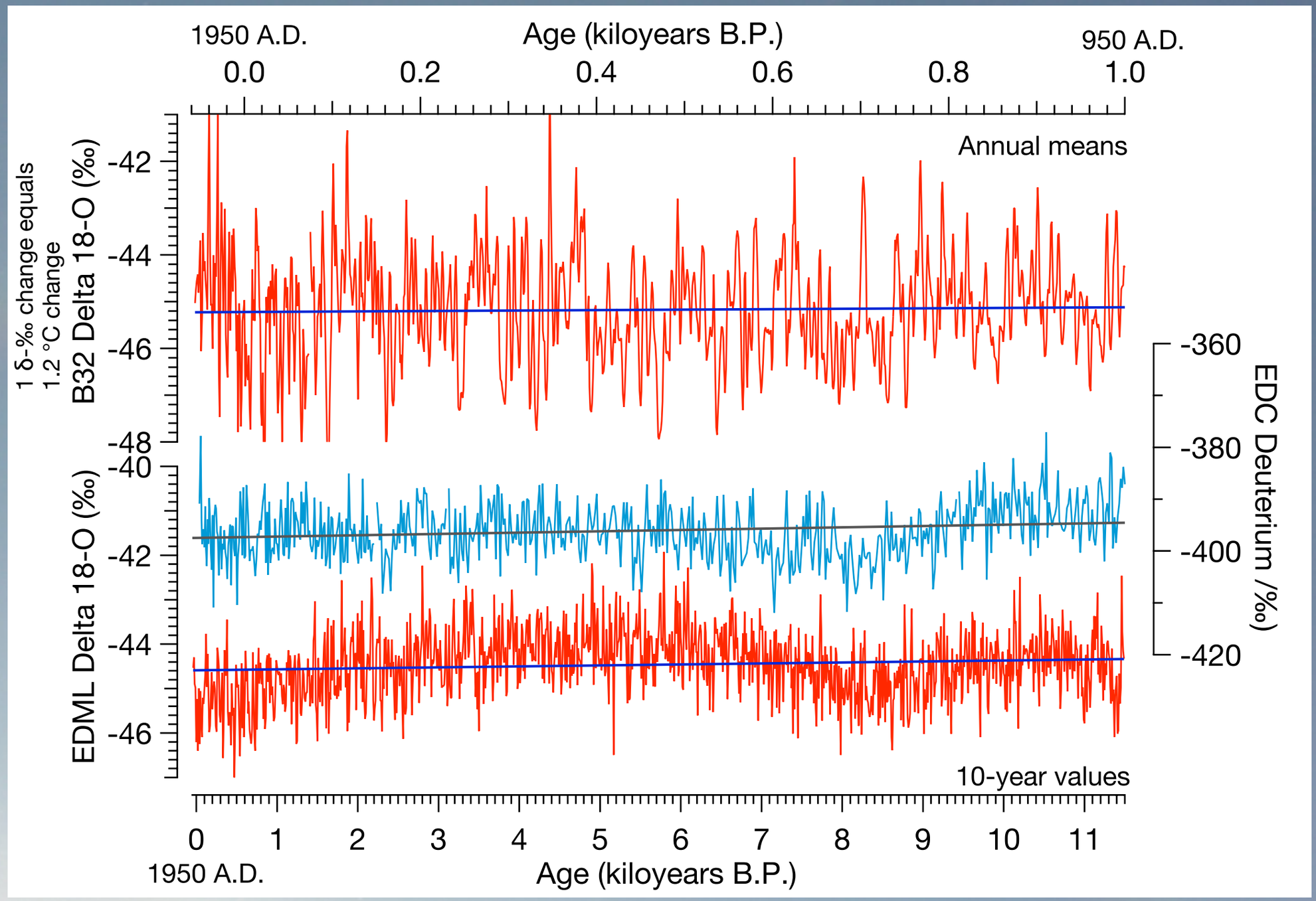
Orbital and Millenial Antarctic Climate Variability over the Past 800,000 Years (2007). *Science* **317**, 793-796 (data: **http://www.ncdc.noaa.gov/paleo/icecore/antarctica/domec/domec_epica_data.html**)

The Holocene

B32:
150m deep ice core, 1.6 km west of EDML, drilled in Dec 1997.

EPICA EDC core

EPICA EDML core



EPICA Community Members (2006): One-to-one coupling of glacial climate variability in Greenland and Antarctica. *Nature* **444**, 195-198 (data: **doi:10.1594/PANGAEA.552270)**

Orbital and Millenial Antarctic Climate Variability over the Past 800,000 Years (2007). *Science* **317**, 793-796 (data: **http://www.ncdc.noaa.gov/paleo/icecore/antarctica/domec/domec_epica_data.html**)

Graf, W. et al. (2002). Stable-isotope records from Dronning Maud Land, Antarctica, Annals of Glaciology, 35, 195-201(data: **doi:10.1594/PANGAEA.104881**)

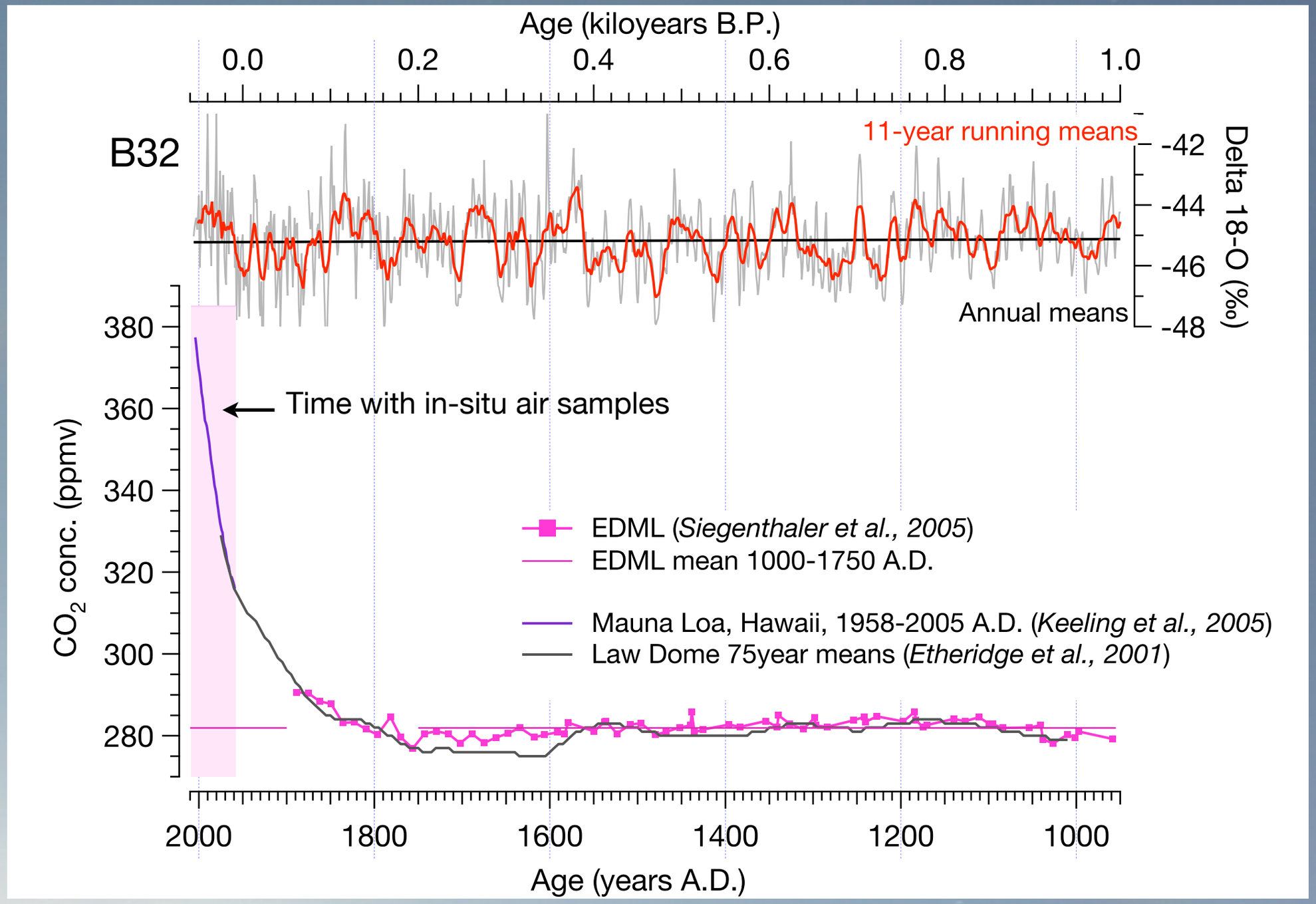
The Holocene

The CO_2 record

foto: hans oerter, 2008

CO_2 record during the past millenium

The EDML CO_2 record is a strong support of the Law Dome record from the Antarctic plateau



Etheridge, D.M., et al. (2001): Law Dome Atmospheric CO_2 Data, IGBP PAGES/World Data Center for Paleoclimatology. Data Contribution Series #2001-083. **NOAA/NGDC** Paleoclimatology Program, Boulder CO, USA.

Keeling, C.D., T.P. Whorf, and the Carbon Dioxide Research Group (2005): Atmospheric CO_2 concentrations (ppmv) derived from in situ air samples collected at Mauna Loa Observatory, Hawaii. Scripps Institution of Oceanography (SIO) University of California La Jolla, California USA

Siegenthaler, U., et al. (2005). Supporting evidence from the EPICA Dronning Maud Land ice core for atmospheric CO_2 changes during the past millenium, T*ellus*, **57B**, 51-57. (**doi:10.1594/PANGAEA.472477**)

Conclusions

Upstream corrections needed

Antarctic Isotope Maxima (AIMs) are counterparts to DO events in Greenland

CH_4 synchronous with DO events

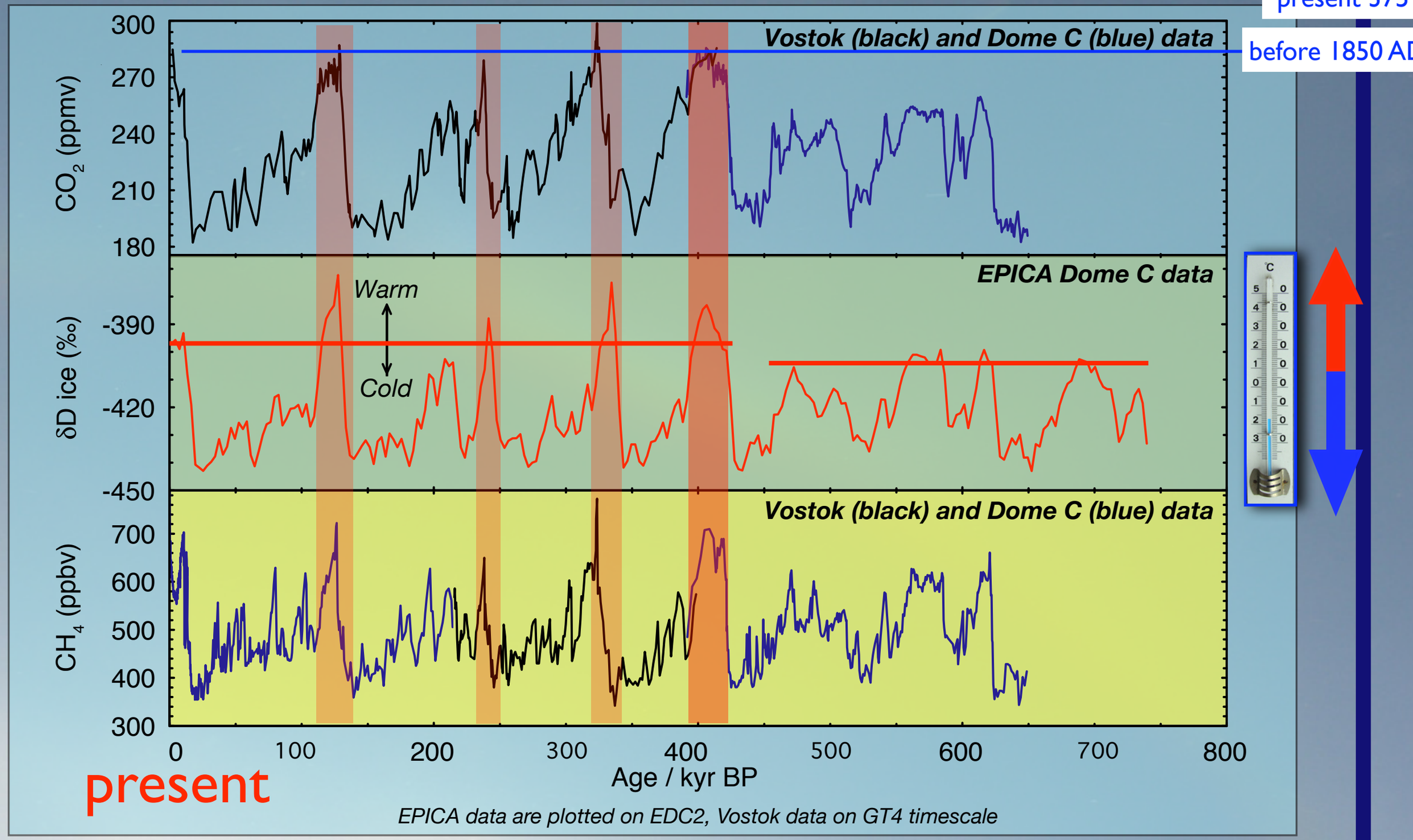
Holocene incl. past Millenium little $\delta^{18}O$ variations

The EDML CO_2 record is a strong support of the Law Dome record from the Antarctic plateau

foto: hans oerter, 2008

Thanks for your attention

Antarctic ice core records: Vostok and EPICA CO_2, CH_4 and δD



EPICA data are plotted on EDC2, Vostok data on GT4 timescale

Petit et al., 1999 (Vostok), Siegenthaler et al., 2005 (Dome C - CO_2),
Spahni et al., 2005 (Dome C - CH_4), EPICA community members, 2004 (δD)

GLOBAL CHANGE IGBP

PAGES PAST GLOBAL CHANGES